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(54) Drying section with a coated drying cylinder

(57) The invention relates to paper machines. In particular, the invention concerns an arrangement for improving the beginning of the drying section joined to closed web transfer between the press section and the drying section in a paper machine. The invention is characterised in that in order to achieve less fouling of the drying cylinder (6_1), that is, less formation of fluff, to achieve easier doctorability and better doctoring tolerance of the drying cylinder surface in the drying section, the surface of at least the first drying cylinder has a coating (60), which includes a thin preferably hard layer (602) of ceramic material and/or metal ceramic and/or metal, to which the web will adhere weakly, and/or another softer material (603), to which the web will adhere weakly, is absorbed into the drying cylinder surface, whereby separation of the web (W) from the surface of the drying cylinder (6_1) is improved.

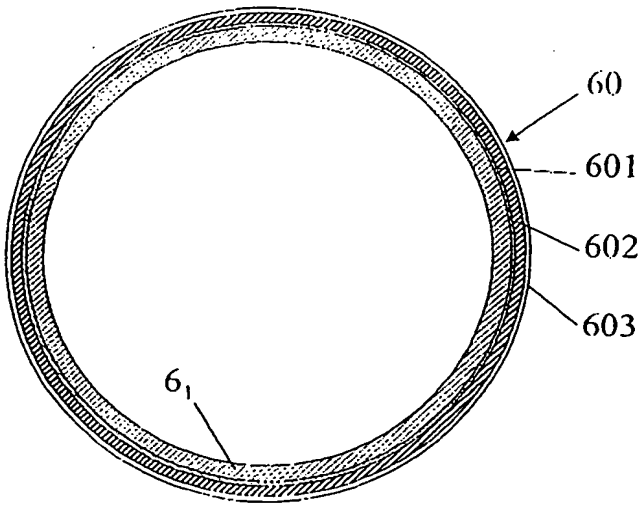

FIG.3.

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Description

[0001] The present invention relates to paper machines. More specifically, the present invention relates to an arrangement for improving the beginning of the drying section joined to the closed web transfer following the press section of the paper machine, in which paper machine: moisture is removed from the web in the press section; and the web is transferred from the press section to a first bank of drying cylinders, in which drying section the web will dry against the heated drying cylinder surfaces essentially to a coating or calendering moisture content.

[0002] In paper machines, the web transfer from the press section to the drying section is typically either open or closed, and the drying cylinders are typically cast iron or steel cylinders.

[0003] An open web transfer means that the web travels freely from the press section to the drying section, that is, without any support from a supporting means, such as typically a transfer belt or felt. In connection with such an open web transfer a drying wire is guided against the web and the web is transferred together with the drying wire and comes into contact with the surface of a drying cylinder made of cast iron or steel. The advantage of open web transfer is that there is hardly any working up or formation of fluff on the web surface, whereby following the drying wire the web will separate relatively easily from the drying cylinder surface and no essential runability problems will occur. However, it is a problem with open web transfer that the web receives all the tensile stress. This is why open web transfer can hardly be used when increasing the running speeds, because with increasing running speeds the tensile stress will grow and then there is an increased risk of web breaks and also other runability problems will begin occurring. A web made under a higher tensile stress will lose even all its stretching potential and the web will adhere more easily to the drying cylinder surface, whereby the web will form a bag in the separation zone, because the web tends to follow the drying cylinder farther than the drying wire, which has already separated from the drying cylinder, which may result in a web flapping phenomenon in the separation zone. Loose material or fibre fluff or bundles may also separate more easily from a web adhering more strongly to the drying cylinder surface, and these will adhere to the drying cylinder surface, from which they must be removed before the drying cylinder again rotates against the web, and the web separates less easily from the drying cylinder surface. In state-of-the-art methods of solving the problem of how to clean the drying cylinder surface, various doctor solutions are used which contact the drying cylinder surface. But it is a common problem with doctors that loose material gathering behind and under the doctor will bypass the doctor and get in contact with the web, whereby loose material will adhere to the web, which adds essentially to the quality problems. Another problem with doctor solutions is that the doctor blade touching the drying cylinder both becomes worn itself and, on the other hand, it also quickly wears the drying cylinder surface. In open web transfer from the press section to the drying section, when associated with closed web transfer through the press section, the leader or the entire web may be run in a controlled fashion down into the pulper immediately after the press section. The advantage of such open web transfer is that the web's separation from the roller surface is essentially less damaging to the web surface than separation of the web from the transfer belt.

[0004] Closed web transfer in the press section and from the press section to the drying section means that in the press section the web travels all the time supported by a supporting means located above and/or under the web. From the press section to the drying section the web is supported by a supporting means, typically a transfer belt or felt, on the upper or bottom side of which the web is supported and it is transferred forward from the press section. In such closed web transfer, the web is separated from the supporting means before the drying cylinder with the aid of a suction roll, whereby an endless supporting means loop travels around the leading roll and the web is pressed against the drying wire travelling around the suction roll and it transfers together with the drying wire to get in contact with the drying cylinder surface. It is an advantage of closed web transfer that the web supporting means receives a part of or all the tensile stress that would otherwise affect the web, whereby by using closed web transfer it is possible to make a web with a higher stretching potential. When the web transfer is closed in the press section and from the press section to the drying section, the first possible place where the web can be run in a controlled fashion down into the pulper, is the first drying cylinder. Since in connection with closed web transfer the web is forced by suction to separate from the supporting means, the problem arises that the web surface is worked up more strongly, that is, it becomes fluffy. For example, fibres stand up from the web surface more strongly than in open web transfer when the web is separated from the supporting means. Due to this fluffing of the web, loose material, such as fibre fluff and bundles, will adhere strongly to the drying cylinder surface made of cast iron or steel, from which they must be removed before the drying cylinder again rotates against the web, and the web is separated less easily from the drying cylinder surface. State-of-the-art methods try to solve the fluffing problem by various doctor solutions touching the drying cylinder surface. However, these have not been able to solve the problem successfully, but due to the fluffing, which is strong at times, loose material gathered behind and under the doctor is allowed to pass by the doctor and get in touch with the web, whereby loose material adheres to the web, which adds essentially to the quality problems. In addition, it is a problem with doctor solutions that the doctor blade touching the drying cylinder surface both becomes worn and it quickly wears the dry-

ing cylinder surface. Closed web transfer has the problem that the web's separation from the surface of the transferring means strongly works up the web, that is, makes it fluffy, whereby the web with its worked-up surface will adhere even more strongly to the drying cylinder surface made of cast iron or steel, in consequence of which the web tends to follow the drying cylinder with its rotating motion, whereby the web forms a bag in the separation zone, because the web follows the drying cylinder farther than the drying wire, which has already separated from the drying cylinder. Hereby loose material will adhere to the drying cylinder surface and will increase the doctoring work and have a harmful effect on the runability of the entire drying section and may even cause a web flapping phenomenon in the separation zone.

[0005] When higher running speeds are the objective, increasing tensile stresses will affect the web during the web transfer. In open web transfer the web will receive all tensile stresses. This is why open web transfer can hardly be used at all at high running speeds, which depending on the kind of paper are typically approximately > 1400-1700 m/min, and in addition, a web made under high tensile stresses may also lose all its stretching potential. Closed web transfer makes possible an increased running speed, while the tensile stresses affecting the web can also be minimised. However, in closed web transfer at higher running speeds a problem arises in increased standing up of fibres, that is, fluffing of the web surface, which will occur in the forced separation of the supporting means and the web. Forced separation is brought about with the aid of the suction of a suction roll affecting the web through the transfer means, e.g. the drying wire. Another drawback with higher transfer speeds is that the length of the drying section required for drying the web to coating or calendering dryness will increase essentially. If the available hall space is limited, which is the case especially in paper machine renewal projects, a top limit restricting the capacity is easily formed for the production capacity which is strongly dependent on the running speed. Surface-coated drying cylinders have earlier been suggested for use in the drying section following the open web transfer. However, coating the drying cylinder results in poorer heat transfer, which is why it is disadvantageous, although on the other hand it is desirable to keep temperatures low in order to prevent burning and sticking. However, temperatures and steam pressures are relatively low in the early part of the drying section, so coating is of no significance to the drying capacity. This is the very reason why the use of coating was and still is considered dubious. It was not realised earlier, however, that coating of the drying cylinder allows using higher temperatures without any risk of burning and sticking, which for its part allows higher running speeds and results in added capacity.

[0006] A first objective of the present invention is to eliminate or at least to reduce the problems relating to the known web transfer and to bring about a new and inventive arrangement for web transfer in a paper machine after the press section. A special objective of the present invention, along with a new and inventive arrangement, is to:

- reduce fouling, that is, formation of fluff, on the drying cylinder,
- improve separation of the web from the drying cylinder surface,
- facilitate doctoring of the drying cylinder surface, and
- reduce wear of both the doctor touching the drying cylinder and of the drying cylinder and to improve the doctoring tolerance of both the drying cylinder and the doctor blade,

and in this way to allow increasing the running speed of the paper machine, to make it possible to make a web with a higher stretching potential.

[0007] In addition, it can be said that the work to overcome friction resistance is reduced, which reduces the need for rotating power required by the drying section, which with increased rotating speeds may constitute a restricting factor in existing machines. At the same time, tension variations in webs are reduced in web-driven systems. The above-mentioned advantages are more obvious when applying the present invention to a great number of drying cylinders.

[0008] These objectives are achieved with the arrangement mentioned in the beginning, which is mainly characterised by the special features mentioned in the characterising part of the independent claim.

[0009] The invention is based on the new and inventive basic idea that in order to achieve less fouling, that is, formation of fluff, on the drying cylinder, to improve separation of the web from the drying cylinder surface, to achieve easier doctoring of the drying cylinder surface and a better doctoring tolerance, the surface of at least the first drying cylinder in the drying cylinder bank is surface-coated or coated with a thin, preferably hard coating, to which the web attaches weakly, or the drying cylinder surface has absorbed a material, to which the web will attach weakly.

[0010] Hereby in a closed web transfer the supporting means of the web will receive entirely or at least partly the tensile stress applied to the web; the web will separate essentially without effort together with the drying wire from the drying cylinder surface; less loose material or fibre fluff or fibre bundles will separate from the web on to the drying cylinder surface; and less cleaning is needed with a doctor stressing the drying cylinder surface.

[0011] In accordance with an advantageous embodiment of the invention, a coating, which is chosen so that adherence of the web to the drying cylinder surface is made as weak as possible, is a ceramic material or metal ceramic or a mixture or compound of these. The coat-

ing may also be a mixture of the above-mentioned ceramic materials or of metal ceramics and a metal. Such a ceramic material or metal ceramic coating, the thickness of which is preferably in a range between 0.03 and 6 mm, can be sprayed thermally on to the roll surface, and in order to ensure adhesion a thin adhesive layer may be used between the coating and the coat iron or steel surface of the cylinder. Alternatively, in order to facilitate the web's separation from the surface, the porous drying cylinder surface may be covered or coated with fluorated plastic or with fluorated epoxy, which has the same properties as fluoroplastic, either alone or in addition to the above-mentioned coating.

[0012] In the following, the invention will be described by way of example with the aid of a preferable embodiment and referring to the appended drawings, wherein

FIG. 1 is a schematic side view of web transfer from the press section to the drying section in a paper machine;
FIG. 2 is a graphic view of the paper web's separation force from different drying cylinder surfaces as a function of the separation angle; and
FIG. 3 is a schematic cross-sectional view of a drying cylinder according to the invention.

[0013] Figure 1 is a schematic view of the press section 1 in a paper machine, wherein water is pressed out of web W and wherein a closed web transfer is arranged for web W through the press section 1 to the drying section 3. In the drying section 3, web W is dried to a solids content required by the web treatment after the drying section, such as e.g. coating or calendering or reeling etc.

[0014] In the press section 1, web W travels through press rolls 14 and 15 in between a press felt 10 and a transfer means 4. In figure 1 the press felt 10 is illustrated by a line of dots and dashes and the endless loop which it forms travels around the leading rolls 12 of the press felt 10. The transfer means 4 is preferably a transfer belt impervious to liquid and/or air, but it may also be a press felt or equivalent, and in Figure 1 it is illustrated by a dashed line. Transfer belt 4 forms an endless loop, which travels around leading rolls 13. After press rolls 14 and 15, press felt 10 is separated from web W, whereupon the web is held on to transfer means 4, which supports it.

[0015] Thus, in press section 1 the web proceeds in closed web transfer on the transfer means 4 to the drying unit 3. In the travelling direction of the web, that is, in the MD direction of the paper machine, the press unit 1 is followed by a suction roll 5, around which a drying wire 8 is turning. Suction affecting in the suction zone of suction roll 5 forces the web W against the drying wire 8, which in Figure 1 is illustrated by a dotted line, and along with this to a first drying cylinder 6_1. In the MD direction the suction roll 5 is followed, preferably immediately, by the leading roll 13 of the transfer means 4, and the leading roll is used to guide the travel of transfer means 4 away from the bottom surface of web W.

[0016] After suction roll 5, web W travels supported against the bottom surface of drying wire 8 to the first bank of drying cylinders of drying unit 3 and into direct contact with the heated cylinder surface of the first drying cylinder 6_1. After the first drying cylinder 6_1 of the first bank of drying cylinders, web W turns around hitch roll 7, whereby drying wire 8 is against the cylinder surface of the hitch roll and web W is outside drying wire 8, to the second drying cylinder 6_2 of the first bank of drying cylinders. Thus, the endless drying wire loop revolving in the first bank of drying cylinders in the drying section travels both by way of the leading rolls 41 of drying wire 8 and also around suction roll 5, the first drying cylinder 6_1 and the first hitch roll 7, and after the first drying cylinder-hitch roll pair 6_1, 7 it zigzags around the following drying cylinder-hitch roll pairs 6_n, 7.

[0017] In order to achieve less fouling of drying cylinders 6_{1-n}, that is, less formation of fluff on the same, to improve the separation of web W from the surface of drying cylinders 6_{1-n}, to achieve easier doctoring and a better tolerance of doctoring of the surface of drying cylinders 6_{1-n}, the surface of at least the first drying cylinder 6_1 of the drying cylinder bank is surface-coated or coated with a thin, preferably hard coating 60. In order e.g. to fill pores or roughness, a coating 60, to which the web will adhere weakly, is absorbed into the surface of the drying cylinder 6_{1-n} made alternatively or optionally of cast iron or with a surface of some other material or with a hard-coated surface. Thus, the absorption material 60 hereby need not cover the metal surface of the drying cylinder 6_{1-n} uniformly and everywhere. In accordance with the invention, the surface-coating or coating or absorption material 60 is chosen so that web W will adhere weakly to the surface-coating or coating or absorption material 60. Hereby web W separates together with drying wire 8 essentially effortlessly from the surface of drying cylinder 6_{1-n} and less loose material or fibre fluff or fibre bundles will separate from web W on to the surface of drying cylinder 6_{1-n}, which again reduces the cleaning work to be done on the surface of drying cylinder 6_{1-n} with a doctor 9_{1a} and with a secondary doctor 9_{1b}.

[0018] When the web transfer is closed in the press section 1 and from the press section 1 and further to the drying section 3, the first possible place where the entire web W can be run in a controlled fashion down into pulper 31, is the first drying cylinder 6_1 after suction roll 5. Hereby it must be possible to doctor the surface of drying cylinder 6_1 strongly and the web must also separate from the surface of the first drying cylinder 6_1 without passing through and past the doctor or doctors 9_{1a}, 9_{1b}.

[0019] Figure 1 shows in connection with the first drying cylinder two successive doctors 9_{1a}, 9_{1b} to ensure that all loose material or the leader or the whole web is safely separated from the surface of drying cylinder 6_1 and guided into the pulper 31 located below.

[0020] The surface-coating in accordance with the in-

vention is arranged in the drying unit in the first drying cylinder 61 of at least the first bank of drying cylinders. It should be emphasised, that in order to minimise adherence and to minimise the need for doctoring, the surface-coating or coating of the surface or absorption of the surface according to the invention may also be arranged in the following drying cylinders 6_{2-n}. Hereby it is possible to reduce the cleaning work stressing the surface of drying cylinders 6_{2-n}, which is to be performed in the whole drying unit by all doctors 9_{2-n}. Another noteworthy advantage is achieved in that loose material or fibre fluff or fibre bundles separate less than before in connection with the cleaning work, whereby less loose material of all kinds is gathered in pulper 31 as a result of the doctoring work. The work to overcome friction resistance is also reduced, which reduces the drying section's need for rotating power, which may form a restricting factor in existing machines with increasing speeds of rotation. At the same time, tension variations in webs are reduced in web-driven systems. The above-mentioned advantages are the more obvious when the present invention is applied to more drying cylinders.

[0021] Figure 3 is a schematic cross-sectional view of the drying cylinder 6_1 according to the invention. The coating 60 according to an advantageous embodiment of the invention of drying cylinder 6_1 includes or the coating 60 consists of a hard layer 602 of a ceramic material, which is preferably oxide ceramic, such as Zr, Al, Si, Ti, Y, Cr oxide ceramics, or carbide ceramic, such as Cr, W, Ti, Ni carbide ceramics. According to the invention, the hard layer 602 may also consist of a mixture or compound of the above-mentioned ceramic materials. Furthermore, the hard layer 602 of coating 60 may according to the invention also be a mixture or compound of the above-mentioned ceramic materials and a metal, preferably chrome, nickel and/or molybdenum. Such mixtures and compounds are generally known by the name of metal ceramics or cermetals or cermet.

[0022] According to the invention, the hard layer 602 of coating 60 may be made not only of a ceramic material or metal ceramics, but also of a metal, which preferably is chrome, molybdenum and/or nickel,

[0023] The thickness of the ceramic material or metal ceramics coating 60 forming the hard layer 602 of coating 60 is preferably in a range of 0.03-6 mm, most preferably in a range of 0.05-2 mm.

[0024] Such a coating 60 can be spread out by plasma spraying or by HVOF (High Velocity Oxy Fuel) spraying thermally on to the roll surface, whereby a surface of ceramic material or metal ceramics is formed. In order to ensure adherence between coating 60 and the surface, for example, such as a cast iron or steel surface, of drying cylinder 6_{1-n}, a thin adhesive layer 601 may be used, which is e.g. a non-porous metal layer, which thus does not have any essential effect on the total thermal conductivity of the drying cylinder and which functions as a protective layer against corrosion at the same time.

[0025] According to a particularly advantageous embodiment of the invention, to promote separation of the web from the surface, fluorated plastic, preferably PTFE (Polytetrafluoroethylene, a known trademark of which is TEFLON®), or fluorated epoxy with the same properties as PTFE, may be absorbed according to the invention into the surface pores or surface profile roughness of the drying cylinder made of cast iron or steel or of the hard layer 602 consisting of a layer of ceramic material and/or metal ceramics and/or metal, to coat or surface-coat the drying cylinder. Of the optional alternatives it is most advantageous that the cast iron or steel surface of the drying cylinder is first surface-coated with the above-mentioned hard coating 602, which is made to adhere to the drying cylinder surface by an adhesive layer 601. Because the hard coating 602 leaves the outer surface porous, fluorated plastic or fluorated epoxy may be absorbed into the pores of the hard surface.

[0026] When fluorated plastic or fluorated epoxy is also absorbed into the coating 60 of the drying cylinder including a hard layer 602, the coating 60 according to the most preferable embodiment of the invention consists of a PTFE coated ceramic material or of PTFE coated metal ceramics.

[0027] The cylinder may also be surface-coated by coating the cylinder surface with fluorated plastic, which is preferably PTFE, with a coated metal layer, wherein the metal is preferably nickel, chrome or molybdenum. Hereby the coating is a PTFE coated metal.

[0028] Figure 2 is a graphic view of the paper web's separation force from different drying cylinder surfaces as a function of the separation angle based on test runs carried out at a production velocity of 22 m/s. From the viewpoint of the invention, the most essential coatings are the following, besides metal coatings:

a. ceramic material coatings, such as Zr, Al, Si, Ti, Y and Cr oxide based oxide ceramic and Cr, W, Ti and Ni carbide based carbide ceramic, e.g. nitride and boride ceramics are also useable ceramics,
b. metal ceramic coatings, which are typically mixtures of oxide or carbide ceramics and metal, preferably Cr, Ni, Mo,
c. metal coatings, preferably Cr, Ni and Mo coatings, as well as
d. PTFE coated hard coatings, which according to the invention are e.g.

i. PTFE coated ceramic materials, whereby

a) the oxide ceramic is preferably Zr, Al, Si, Ti, Y or Cr oxide, and/or
b) the carbide ceramic is preferably Cr, W, Ti or Ni carbide,

ii. PTFE coated hard coatings, whereby preferably

a) the oxide ceramic is e.g. Zr, Al, Si, Ti, Y

or Cr oxide and the metal is Cr, Ni or Mo, and/or
b) the carbide ceramic is e.g. Cr, W, Ti or Ni carbide and the metal is Cr, Ni or Mo

iii. PTFE coated metals, whereby the metal is e.g. Cr, Ni or Mo.

[0029] Figure 2 illustrates the separation force of the paper web from surfaces, which are:

i. a PTFE nickel surface representing a PTFE coated metal coating,
ii. an aluminium oxide ceramic surface representing ceramic material coating, and
iii. a tungsten carbide cobalt surface representing metal ceramic coating.

[0030] In addition, Figure 2 illustrates for the sake of comparison the separation force of the paper web from a cylinder surface made of cast iron or steel at a corresponding production velocity.

[0031] As can be seen in Figure 2, with each coating according to the invention the paper web separates from the coated cylinder surface with an essentially lower separation force than from a cylinder surface made of cast iron or steel. Hereby the risk of fluff formation is reduced and that way also fouling of the cylinder surface.

[0032] The invention was described above only by way of example with the aid of its one mode of application, which is considered advantageous. Of course, this does not mean any intention to limit the invention in any way to concern such an individual example only, and as is obvious to the professional in the art, alternative solutions and modifications are possible within the scope of the new and inventive idea defined in the appended claims.

[0033] Thus it should be noted that between the press section and drying section shown in Figure 1 it is possible to arrange one or more desired units, e.g. a web transfer and/or pre-drying unit, on to which the web is taken from the press section as closed web transfer and from which the web is taken further as closed web transfer to the drying section, the first drying cylinder of which is a coated drying cylinder in accordance with the invention.

[0034] The above description and the following claims are based essentially on the following terminology and concepts:

1. metal:
i. a metallic material or a metal alloy
2. ceramic material:
ii. a ceramic material, such as oxide or carbide ceramic, or a mixture or compound of ceramic materials
3. oxide ceramic:
iii. a ceramic formed by oxidisation, usually a metal oxide
4. carbide ceramic:
iv. a carbide usually formed by carbon and a metal
5. metal ceramic:
v. a mixture or compound of a ceramic material and a metal

Claims

1. Arrangement for improving the beginning of the drying section (3) joined to closed web transfer after the press section (1) in a paper machine, in which paper machine: moisture is removed from the web (W) in the press section (1); and the web is guided from the press section to the first bank of drying cylinders of the drying section (3), in which drying section (3) the web dries against heated drying cylinder surfaces essentially to the solids content required for treatment of the web after the drying section (3), such as e.g. coating or calendering or reeling or other such, **characterised in that** in order to achieve less fouling of the drying cylinder (6_{1-n}), that is, less fluff formation, to achieve better doctorability and better doctoring tolerance of the drying cylinder (6_{1-n}) surface in the drying section (3) there is a coating (60) on the surface of at least the first drying cylinder (6_1), which coating includes a thin, preferably hard layer (602) of ceramic material and/or metal ceramic and/or metal, to which the web will adhere weakly, and/or another softer material (603), to which the web will adhere weakly is absorbed into the drying cylinder (6_{1-n}) surface, whereby separation of the web (W) from the surface of the drying cylinder (6_{1-n}) is improved.

2. Arrangement as defined in claim 1, **characterised in that** at least the first two drying cylinders (6_{1-n}) of the drying section (3) include a thin preferably hard coating layer (60) of a ceramic material and/or metal ceramic and/or metal.

3. Arrangement as defined in claim 1 and/or 2, **characterised in that** fluorated plastic or fluorated epoxy (603) is absorbed into the surface of the drying cylinder ($6_{1...n}$).

4. Arrangement as defined in claim 3, **characterised in that** the fluorated plastic is polytetrafluoroethylene.

5. Arrangement as defined in claim 1 and/or 2, **characterised in that** the coating (60) of the drying cylinder ($6_{1...n}$) made of cast iron or steel includes a lower hard layer (602), which is of a ceramic material, metal ceramic and/or metal, and a softer layer (603) of fluorated plastic or epoxy of the kind ab-

sorbed into the hard layer (602).

6. Arrangement as defined in claim 1 and/or 2, **characterised in that** the coating (60) consists of a hard layer (602) only, which is ceramic material, metal ceramic and/or metal.

7. Arrangement as defined in any one of claims 1-6, **characterised in that** the ceramic material (602) forming the hard layer (602) of the coating (60) is oxide ceramic, preferably Zr, Al, Si, Ti, Y or Cr oxide ceramic, and/or carbide ceramic, preferably Cr, W, Ti or Ni carbide ceramic.

8. Arrangement as defined in any one of claims 1-6, **characterised in that** the metal ceramic forming the hard layer (602) of the coating (60) is a mixture or compound of an oxide ceramic, which is preferably Zr, Al, Si, Ti, Y or Cr oxide ceramic, and/or a carbide ceramic, which is preferably Cr, W, Ti or Ni carbide ceramic, and a metal, which is preferably Cr, Ni or Mo.

9. Arrangement as defined in any one of claims 1-6, **characterised in that** the metal forming the hard layer (602) of the coating (60) is preferably Cr, Ni or Mo.

10. Arrangement as defined in any one of claims 1-6, **characterised in that** the lower hard layer (602) of the coating (60) is a mixture or compound of at least two materials, which materials have been chosen from a set including:

    - oxide ceramics, preferably Zr, Al, Si, Ti, Y and Cr oxide ceramics,
    - carbide ceramics, preferably Cr, W, Ti and Ni carbide ceramics,
    - metal ceramics, preferably Zr, Al, Si, Ti, Y and Cr oxide ceramics, and/or mixtures or compounds of Cr, W, Ti or Ni carbide ceramics and metals, preferably Cr, Ni or Mo, and
    - metals, preferably Ni, Cr and Mo,

    and that a softer layer (603) of fluorated plastic, such as PTFE, and/or fluorated epoxy, is absorbed into the surface of the hard layer (602).

11. Arrangement as defined in any one of claims 1-10, **characterised in that** the thickness of the hard layer (602) of a ceramic material and/or a metal ceramic in the coating (60) is preferably in a range of 0.03-6 mm, most preferably in a range of 0.05-2 mm.

12. Arrangement as defined in any one of claims 1-11, **characterised in that** the hard layer (602) of the coating (60) is sprayed thermally on to the surface of the drying cylinder (6_{1-n}) and that to ensure adhesion an adhesive layer (601), which is preferably a non-porous metal layer, is used in between the hard layer (602) of the coating (60) and the cast iron or steel cylinder surface of the drying cylinder (6_1, 6_2, 6_n).

13. Arrangement as defined in any one of claims 1-12, **characterised in that** fluorated plastic is absorbed into the coating (6) including the hard layer (602), whereby the coating (60) consists of a PTFE coated ceramic material or of a PTFE coated metal ceramic or of a PTFE coated metal.

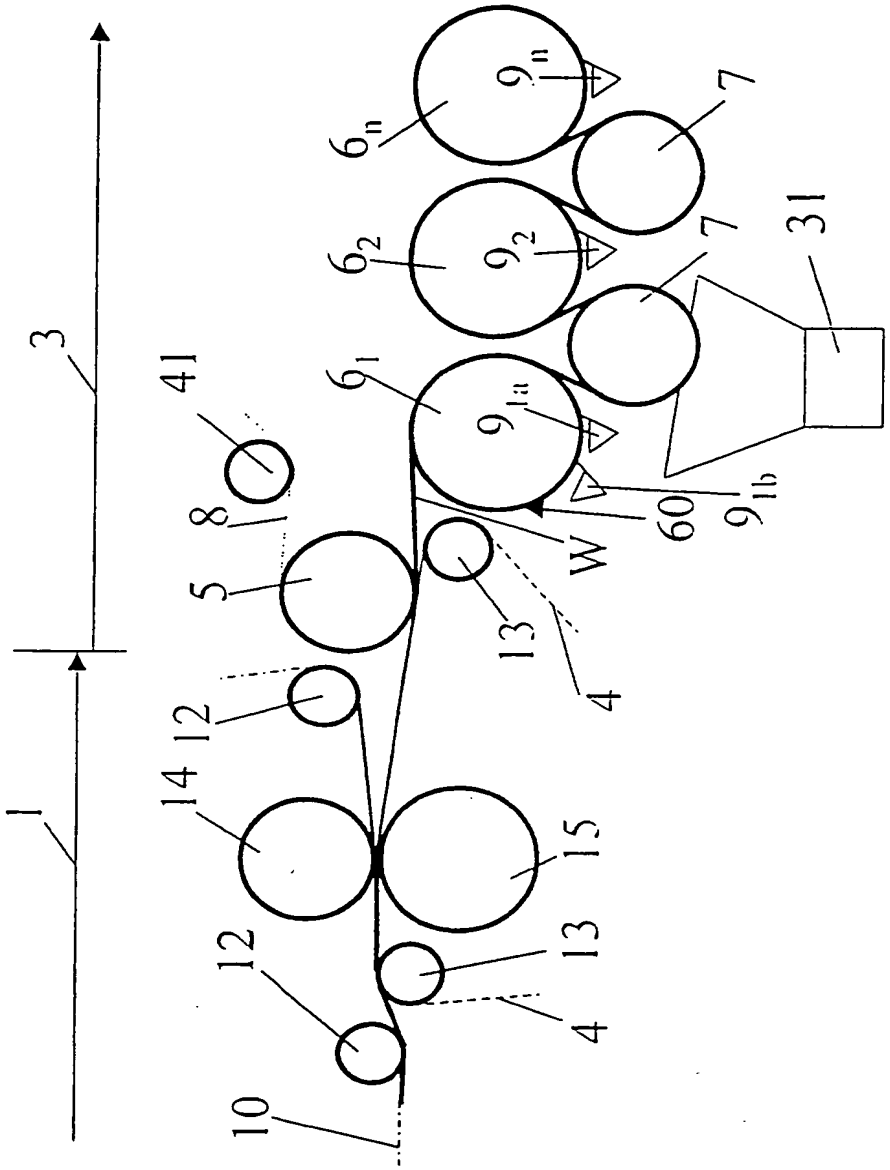

FIG.1.

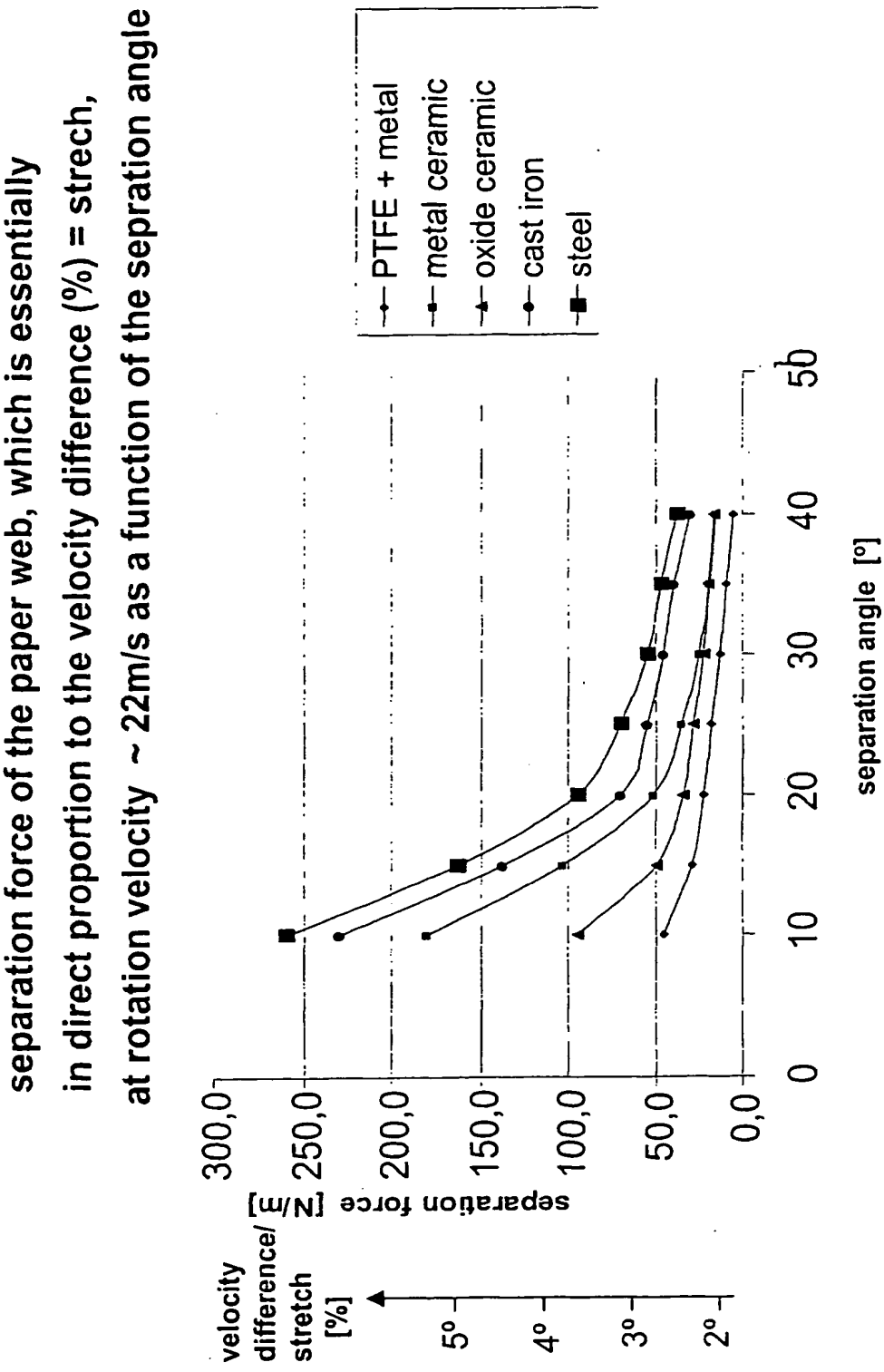
separation force of the paper web, which is essentially
in direct proportion to the velocity difference (%) = strech,
at rotation velocity ~ 22m/s as a function of the sepration angle
PTFE + metal
metal ceramic
oxide ceramic
cast iron
steel
separation force [N/m]
300,0
250,0
200,0
150,0
100,0
50,0
0,0
0
10
20
30
40
50
separation angle [°]
velocity difference/ stretch [%]
5°
4°
3°
2°

FIG.2.

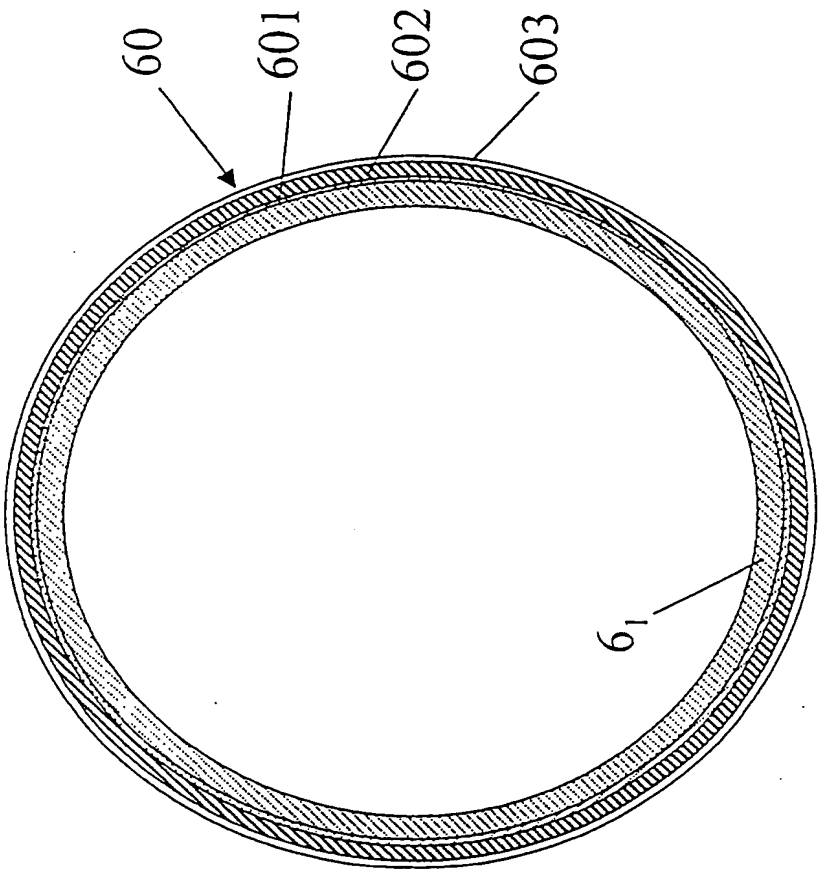

FIG.3.